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Effect of the Fukushima earthquake on weight in early childhood

- a retrospective analysis

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ABSTRACT

Objective

There have been no reports evaluating the physical growth in early childhood in Fukushima Prefecture after the Great East Japan earthquake. We retrospectively investigated the health examination data in early childhood (aged 0–3 years).

Methods

We divided the affected children into respective groups according to the interval from the disaster to the time of health examination and age, as follows: group I, birth to 3–4 months in boys [1.81 (range, 0–6 months)] and girls [1.79 (range, 0–7 months)]; group II, 3–4 months to 6–10 months in boys [6.37 (range, 3–9 months)] and girls [6.35 (range, 3–9 months)]; group III, 6–10 months and 18 months in boys [16.2 (range, 5–22 months)] and girls [16.9 (range, 5–22 months)]; and group IV, 18 months to 36–42 months in boys [21.0 (range, 18–24 months)] and girls [21.0 (range, 18–24 months)]. Using height and body mass index, the health status of each group was compared with that of unaffected controls (i.e., children who experienced the disaster after their health examination at 36–42 months).

Results

The change in body mass index between the health examinations at 18 months and 36–42 months was significantly increased in group I (95% CI: all boys, 0.192–0.276 vs.

−0.006–0.062, $p < 0.001$ and all girls, 0.108–0.184 vs. −0.109 to −0.035, $p < 0.001$) and group II (95% CI: all boys, 0.071–0.141 vs. −0.006–0.062, $p = 0.002$ and all girls, −0.042–0.024 vs. −0.109 to −0.035, $p = 0.013$).

Conclusions

Children who were affected by the disaster in Fukushima Prefecture in early childhood were overweight. The use of pre-existing information, such as health examination data, was beneficial for investigation of the physical growth of affected children.

INTRODUCTION

The Great East Japan earthquake occurred on March 11, 2011 [1] and caused a great deal of damage in the areas of Iwate, Miyagi, and Fukushima Prefectures.[2] The resultant tsunami destroyed many houses on the Pacific coast and forced many people in the area to evacuate. Moreover, the Fukushima Daiichi Nuclear Power Plant accident forced many people living around the power plant to leave their homes. Therefore, the residents in Fukushima Prefecture were likely influenced, either directly or indirectly, by the earthquake disaster. The influence of the disaster on affected adults and nursery school children over the age of 3 years has been reported.[3-9] In this study, we performed a growth survey on children who were affected in early childhood (aged 0–3 years) in Fukushima Prefecture.

Generally, body mass index (BMI) is used to assess physical data, such as obesity, in adults. However, BMI cannot be compared among children because it varies in different age groups and changes substantially with age. In order to standardize the height and BMI in childhood according to sex and age, we used the standard deviation score (SDS).

METHODS

Study design and subjects

The survey design and population were described in detail in a previous paper.[10]

According to the Maternal and Child Health Act, local governments across Japan must perform health examinations between 18 months and 2 years old and between 3 years and 4 years old.[11] Moreover, publicly funded infant medical examinations are carried out in Fukushima Prefecture at 3–4 and 6–10 months of age. We sought to retrospectively investigate the records of these five health examinations, including those at birth, and invited all local governments in Fukushima Prefecture to participate in the survey. Eventually, 31 of 57 local governments, representing 79.6% of the total number of births in Fukushima Prefecture during the target periods, participated in this survey (Figure 1).

Data were provided by the one of the following methods: 1) completion of survey sheets by public health nurses who were employed by the local governments, 2) visits to local health centers to transcribe health examination data, or 3) submission of electronic datasets of pre-existing health examination records from which all personally identifiable information were removed. The survey was conducted from July 2012 to October 2014, in order to collect data on children who were born over a relatively wide range of birth years.

During the periods of investigation, we collected data on 4,387 children who were born between March 1, 2007 and August 31, 2007 and who experienced the disaster and its after effects after their 36–42-month health examinations; on 6,167 children who were born between March 1, 2009 and August 31, 2009 and experienced the disaster before their 36–42-month health examinations; and on 10,046 children who were born between June 1, 2010 and April 30, 2011 and who either experienced the disaster when they were under 10 months old or were not yet born. During these target periods, data were collected from a total of 20,600 children, who accounted for 81.9% of the 25,148 total number of births registered by the 31 local governments.

We classified the children into the following six groups: 1) group zero included children who experienced the disaster before birth; 2) group I included children who experienced the disaster between birth and their 3–4-month health examination; 3) group II included children who experienced the disaster between their 3–4- and 6–10-month health examinations; 4) group III included children who experienced the disaster between their 6–10-month and 18-month health examinations; 5) group IV included children who experienced the disaster between their 18-month and 36–42-month health examinations; and 6) the control group, which included 3,206 children who experienced the disaster after their 36–42-month health examinations.

We aimed to compare the groups based on the age when the children experienced the disaster and their physical activity level (Figure 2). In the process of gathering such necessary data (Figure 3) and in order to ensure that the data gathered were from the same children in all health examinations, we used only complete data from at least four health examinations and excluded the incomplete data. Group zero represented the group of children who experienced the disaster before birth and were, therefore, not eligible and excluded from this survey. The number of children who satisfied the definition of group III during the first data collection was very few. Because of this small number and the large difference in the populations, group III was not comparable with the other groups under equal conditions and was excluded. We eventually used the available data from 12,008 children.

From the Pacific coast side to the west, Fukushima Prefecture is separated into three areas (i.e., Hamadori, Nakadori, and Aizu) by mountains and highlands that are 500–2,000 meters above sea level. The distance from the west side of the Fukushima Daiichi Nuclear Power Plant to the Hamadori, Nakadori, and Aizu areas are approximately 0–85 km, 15–100 km, and 70–170 km, respectively. It was thought that the degree of actual radioactive contamination differed among the three areas (Figure 1), and the influence on the residents of Fukushima Prefecture was likewise expected to differ. Therefore, we

further divided each of the four groups according to these three areas and evaluated the corresponding influence of the disaster (Table 1 and Supplementary Table 1-6).

Statistical analysis

We assessed height and BMI using the records at birth and each of the health examinations undertaken at 3–4 months, 6–10 months, 18 months, and 36–42 months of age. Due to the fact that BMI in childhood changes substantially with age, comparison of BMI among children of different age groups is difficult. Moreover, the age in months of children taking the same health examination varies. For that reason, it was necessary to standardize each BMI in childhood according to sex and age. Cole constructed centile curves for BMI using the LMS method, which was adopted by Inokuchi et al for the Japanese population.[12, 13] Therefore, we are now able to express BMI as SDS. Standard deviation (SD) is defined as the square root of the variance and represents the width of the distribution. The zero of SDS represents the average value, and the SDS represents the number of times that the SD diverges from the average value. We converted the height and BMI of all children to height SDS and BMI SDS using a calculation software,[14] then calculated the Δ BMI SDS as the difference in BMI SDS between two consecutive health examinations, as follows: between birth and 3–4 months, between 3–4 and 6–10 months, and between 18 and 36–42 months.

Using the Microsoft Excel 2010 software package for Windows, the t-test was performed to assess the significance of differences in height SDS, BMI SDS, and Δ BMI SDS. We stratified the indicators by region and sex in order to examine the differences between the control group and groups I, II, and IV. In our analysis, because there were three pairwise comparisons between the control group and the other three groups for each analysis stratified by region and sex, a p value of less than 0.016 was regarded as statistically significant using the Bonferroni correction.

Ethics committee approval

The survey protocol was approved by the institutional review board of Fukushima Medical University (authorization number 1487). Our survey was conducted in accordance with the National Ethical Guidelines for Epidemiological Research.[15] We collected only existing data and, therefore, did not obtain informed consent from the participants. Accordingly, we disclosed information, including the significance, objectives, and methods of the survey, to the public via the website of the School of Medicine, Tohoku University (<http://www.med.tohoku.ac.jp/public/ekigaku2013.html>).

RESULTS

We compared the height SDS, BMI SDS, and Δ BMI SDS before and after the disaster between the affected children (group I, II, and IV) and the unaffected children (control group). Moreover, we compared the Δ BMI SDS in these groups according to the three areas (i.e., Hamadori, Nakadori, and Aizu).

Height SDS

As shown in Figure 4 and Table 2, no significant differences were observed between the control group and groups I, II, and IV.

BMI SDS

As shown in Figure 5 and Table 3, the BMI SDS of groups I, II, and IV were equal to or less than that of the control group before the disaster. After the disaster, on the 36–42-month health examination, the BMI SDS for boys in the control group [95% confidence interval (CI): 0.187–0.277] was significantly lower than that in group I (95% CI: 0.298–0.404; $P = 0.001$) and group II (95% CI: 0.302–0.390; $p < 0.001$). For girls, the BMI SDS in the control group (95% CI: 0.162–0.250) was significantly lower than that in group I (95% CI: 0.240–0.346; $p = 0.013$) and group II (95% CI: 0.265–0.355; $p = 0.001$).

ΔBMI SDS

As shown in Figure 6 and Table 4, in the Hamadori area, the ΔBMI SDS between the 3–4 and 6–10 month health examinations for boys was higher in group I than in the control group (95% CI: 0.085–0.233 vs. –0.124–0.030, $p < 0.001$). The ΔBMI SDS between the 18 months and 36–42 months health examinations was significantly higher in group I than in the control group in both boys (95% CI: 0.319–0.473 vs. –0.052–0.068, $p < 0.001$) and girls (95% CI: 0.208–0.342 vs. –0.206 to –0.048, $p < 0.001$). The ΔBMI SDS between the 18 months and 36–42 months health examinations was significantly higher in group II than in the control group in both boys (95% CI: 0.163–0.285 vs. –0.052–0.068, $p < 0.001$) and girls (95% CI: 0.019–0.148 vs. –0.206 to –0.048, $p < 0.001$).

In the Nakadori area, the ΔBMI SDS between the 18 months and 36–42 months health examinations was significantly higher in group I than in the control group in both boys (95% CI: 0.123–0.233 vs. 0.008–0.100, $p = 0.001$) and girls (95% CI: 0.062–0.166 vs. –0.086–0.004, $p < 0.001$). For all of the three periods in the Aizu area, no significant differences were observed between the control group and groups I, II, and IV.

DISCUSSION

The Δ BMI SDS between the 18 months and 36–42 months health examinations was significantly increased in children who experienced the disaster between birth and their 6–10-month health examination. Also, a trend toward overweight children was observed in the Hamadori and Nakadori areas, but not in the Aizu area. Likewise, previous reports among nursery school children reported that unlike Iwate and Miyagi prefectures, overweight was characteristically observed in Fukushima Prefecture with a significant difference.[6, 9] It was described that the difference might be caused by unbalanced diet and restricted physical activities. The children of Group I and II in this survey, however, had mainly drunk milk around the time of disaster. Therefore, an association of the observed overweight and unbalanced diet was unlikely.

On the other hand, in the aftermath of the tsunami, Fukushima Prefecture was severely affected by the Fukushima Daiichi Nuclear Power Plant accident. The radiation levels were relatively high in the Hamadori area, somewhat elevated in the Nakadori area, and only slightly elevated in the Aizu area (Figure 1).[16] After the accident, the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Health, Labour and Welfare of Japan jointly released a statement on restrictions to outdoor activity in all schools and nursery schools based on the air radiation. Restrictions on outdoor

activity were enforced by the local governments across almost all of the Hamadori area and much of the Nakadori area that had high radiation levels.[17, 18]

There was a relatively close correlation between the areas with high air radiation level in which restriction of outdoor activity was deemed necessary and the areas in which a trend toward overweight children was observed. The impact of restriction of outdoor activity after the disaster might have been more significant on children aged over one old than on other children, probably because of the fact that toddlers are generally encouraged and actually begin to engage in various activities, including outdoor play, after one year old.[19] Based on the above, the restriction of outdoor activity as one of potential causes of the presented trends in overweight in Fukushima Prefecture; significant overweight after 1 year of age and its regional differences.

Body mass in young adults is strongly related to body mass in childhood.[20] Moreover, an early adiposity rebound has been found to be significantly associated with BMI level at a later age and an increased risk for being overweight.[21, 22] Early detection of adiposity rebound is important in preventing metabolic syndrome.[23] It is also important to promote early intervention in order to prevent adult obesity. Some studies have reported that stress on the affected mothers caused growth failure in children during the perinatal period [24, 25 and is a risk factor for childhood obesity.[26] Early

intervention for the affected mothers prior to delivery is, therefore, also necessary to preserve the health of their children.[27]

There are three limitations to this study. First, we used data from only 31 of 57 local governments that agreed to participate in this survey. Nevertheless, these local governments were large municipalities and covered 79.6% of the number of childbirths in Fukushima Prefecture during the target periods. Second, we did not investigate the causes of overweight in detail and outdoor activity itself in early childhood; there had been no comprehensive or extensive survey on outdoor activity in early childhood after the disaster. Being overweight may be associated with an unbalanced diet; the changes in the eating habits in the evacuation area were considered to be one of the causes of adult obesity.[5, 28] However, there are no reports on the relationship between early childhood diet, such as milk or baby food, and changes in body size before and after the disaster. Another possible cause of overweight is stress, and it has been shown that stress may cause growth failure and lead to being overweight. Sleep disorders may also be an important factor in being overweight among affected adults and children.[29, 30] However, we did not investigate in this study the influence of stress and sleep disorders on being overweight. Therefore, diet, stress, and sleep disorders cannot be excluded as factors that might have contributed to being overweight in this study. Lastly, because of unequal interval between data collections, the number of children included in group III

became much smaller than the other groups. Consecutive data collection could have minimized the difference between sample sizes of the groups analyzed.

We retrospectively analyzed the data on health examination and discovered that the availability of normal baseline data for comparison with those after the event were useful. The health examination data from within Fukushima prefecture is large, but not all could be obtained and the only common variables available were height and weight. The use of an online backup service and standardization of the format of data sheets to manage health examination records nationwide will likely enable easier collection of more data.

Conclusion

After the disaster, being overweight was observed between the 18 months and 36–42 months health examination in children who experienced the disaster between birth and their 6–10-month health examination; this trend was observed in the Hamadori and Nakadori areas where the radiation levels were relatively high. The use of pre-existing health examination data in early childhood, when physical growth was marked, was beneficial because the physical examination findings were described in detail.

Acknowledgments

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Funding and Competing interests:

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Abbreviation: SDS – Standard Deviation Score, BMI – Body Mass Index, LMS method – Lambda-Mu-Sigma method

What is known about the subject

After the 2011 Great East Japan Earthquake, lifestyle diseases, such as obesity, in affected adults were reported. Recently, overweight in nursery school children aged over three years and who were affected by the disaster has also been reported.

What this study hopes to add

After the disaster in Fukushima Prefecture, a trend toward being overweight was observed in early childhood (age 1 to 3 years). The use of pre-existing data on early childhood, such as health examination data, was beneficial for investigating the physical growth of the affected children.

REFERENCES

1. Japan Meteorological Agency. Information on the 2011 Great East Japan Earthquake.

http://www.data.jma.go.jp/svd/eqev/data/2011_03_11_tohoku/ (accessed 20 April, 2017).

2. National Police Agency of Japan. Damaged situation and police countermeasures associated with 2011 Tohoku district–off the Pacific Ocean Earthquake.

https://www.npa.go.jp/archive/keibi/biki/higaijokyo_e.pdf Updated December 9, 2016 (accessed 20 April, 2017).

3. Tsubokura M, Takita M, Matumura T, et al. Changes in metabolic profiles after the Great East Japan Earthquake: a retrospective observational study. *BMC Public Health* 2013;13:267. doi: 10.1186/1471-2458-13-267.

4. Kawasaki Y, Hosoya M, Yasumura S, et al. The basic data for residents aged 16 years or older who received a comprehensive health check examinations in 2011-2012 as a part of the Fukushima health management survey after the Great East Japan Earthquake. *Fukushima J Med Sci* 2014;60:159–69.

5. Ohira T, Hosoya M, Yasumura S, et al. How lifestyle affects health–changes in health status before and after the earthquake. *Fukushima J Med Sci* 2014;60:211–2.

6. Yokomichi H, Zheng W, Matsubara H, et al. Impact of the great east Japan earthquake on the body mass index of preschool children: a nationwide nursery school survey. *BMJ Open* 2016;6: e010978. doi: 10.1136/bmjopen-2015-010978
7. Zheng W, Yokomichi H, Matsubara H, et al. Longitudinal changes in body mass index of children affected by the Great East Japan Earthquake. *Int.J Obes (Lond)* 2017;41:606–12.
8. Kikuya M, Matsubara H, Ishikuro M, et al. Alterations in physique among young children after the Great East Japan Earthquake: Results from a nationwide survey. *J Epidemiol* 2017;27:462–8. doi: 10.1016/j.je.2016.09.012
9. Isojima T, Yokoya S, Ono A, et al. Prolonged elevated body mass index of preschool children after The Great East Japan Earthquake. *Pediatr Int* 2017;59:1002–9. doi: 10.1111/ped.13340
10. Matsubara H, Ishikuro M, Kikuya M, et al. Design of the health examination survey on early childhood physical growth in the Great East Japan Earthquake affected areas. *J Epidemiol.* 2017;27:135–42. doi: 10.1016/j.je.2016.03.001.
11. National Diet Library. Maternal and Child Health Act, Law number: Act No. 141 of 1965 (in Japanese).
http://law.e-gov.go.jp/cgi-bin/idxselect.cgi?IDX_OPT=1&H_NAME=%95%ea%8e%71%95%db%8c%92&H_NAME_YOMI=%82%a0&H_NO_GENGO=H&H_NO_YEAR

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12. Cole TJ. The LMS method for constructing normalized growth standards. *Eur J Clin Nutr* 1990;44:45–60.

13. Inokuchi M, Hasegawa T, Anzo M, et al. Standardized centile curves of body mass index for Japanese children and adolescents based on the 1978-1981 national survey date. *Ann Hum Biol* 2006;33:444–53.

14. The Japanese Society of Pediatric Endocrinology. Software for BMI and BMI percentile SDS. <http://jspe.umin.jp/medical/taikaku.html> (accessed 20 April, 2017).

15. Ministry of Education, Culture, Sports, Science and Technology, and Ministry of Health, Labour and Welfare. Ethical Guidelines for Epidemiological Research (in Japanese). http://www.lifescience.mext.go.jp/files/pdf/37_139.pdf (accessed 20 April, 2017).

16. Fukushima Prefecture. Result of monitoring survey of radiation levels in Fukushima Prefecture. <https://www.pref.fukushima.lg.jp/sec/16025d/kako-monitoring.html>. (accessed 20 April, 2017).

17. Ministry of Health, Labour and Welfare, Japan. The temporary way of thinking in the use judgements of buildings and grounds of nursery schools in Fukushima.

<http://www.mhlw.go.jp/stf/houdou/2r98520000019qpz-att/2r9852000001nluo.pdf>.

(accessed 20 April, 2017).

18. Ministry of Education, Culture, Sports, Science and Technology, Japan. The temporary way of thinking in the use judgements of buildings and grounds of schools in Fukushima. http://www.mext.go.jp/a_menu/saigaijohou/syousai/1305173.htm).

(accessed 20 April, 2017).

19. Tremblay MS, Leblanc AG, Carson V, et al. Canadian Physical Activity Guidelines for the early years (aged 0-4 years). *Appl Physiol Nutr Metab* 2012;37:345–69.

20. Tsukada H, Miura K, Kido T, et al. Relationship of childhood obesity to adult obesity: A 20-year longitudinal study from birth in Ishikawa prefecture, Japan (in Japanese). *Nihon Koshu Eisei Zasshi* 2003;50:1125–34.

21. Rolland-Cachera MF, Deheeger M, Bellisle F, et al. Adiposity rebound in children: a simple indicator for predicting obesity. *Am J Clin Nutr* 1984;39:129–35.

22. Rolland-Cachera MF, Deheeger M, Mailliot M, et al. Early adiposity rebound: causes and consequence for obesity in children and adults. *Int J Obes (Lond)* 2006;30 Suppl 4:S11–7.

23. Koyama S, Ichikawa G, Kojima M, et al. Adiposity rebound and the development of metabolic syndrome. *Pediatrics* 2014;133:e114–9. doi: 10.1542/peds.2013-0966.

24. Harville E, Xiong X, Buekens P. Disasters and perinatal health: a systematic review.

Obstet Gynecol Surv 2010;65:713–28.

25. Bromet EJ, Havenaar JM, Guey LT. A 25 year retrospective review of the

psychological consequences of the Chernobyl accident. *Clin Oncol (R Coll Radiol)*

2011;23:297–305.

26. Dancause KN, Laplante DP, Fraser S, et al, Prenatal exposure to a natural disaster

increases risk for obesity in 5¹/₂-year-old children. *Pediatr Res* 2012;71:126–31.

27. Goto A, Bromet EJ, Fujimori K, Pregnancy and Birth Group of Fukushima Health

Management Survey. Immediate effects of the Fukushima nuclear power plant disaster

on depressive symptoms among mothers with infants: a prefectural-wide cross-sectional

study from the Fukushima Health Management Survey. *BMC Psychiatry* 2015;15:59.

doi: 10.1186/s12888-015-0443-8.

28. Inoue T, Nakao A, Kuboyama K, et al. Gastrointestinal symptoms and

food/nutrition concerns after the great East Japan earthquake in March 2011: survey of

evacuees in a temporary shelter. *Prehosp Disaster Med* 2014;29:303–6.

29. Ohira T, Hosoya M, Yasumura S, et al. Effect of evacuation on body weight after

the Great East Japan Earthquake. *Am J Prev Med* 2016;50:553–60.

30. Halal CS, Matijasevich A, Howe LD, et al. Short sleep duration in the first years of life and obesity/overweight at age 4 years: A birth cohort study. *J Pediatr* 2016;168:99–103.

FIGURE LEGENDS

Figure 1

Upper: The 31 local governments that participated in this survey are shown on the map of Fukushima Prefecture. Lower: The air radiation dose from March 2011 to December 2014 for each of the three areas is shown.

◆: Hamadori area, ■: Nakadori area, ▲: Aizu area

Figure 2

The health examination periods (birth, 3–4 months, 6–10 months, 18 months, and 36–42 months) and the six groups (zero, I, II, III, IV, and control) divided according to the age during the disaster and average (range) age of each group.

M, month health examination

Figure 3 The number of data collected from the 31 local governments participating in this survey.

Figure 4 Height SDS of all boys and girls in Fukushima Prefecture

◆: Control Group, ■: Group I, ▲: Group II, ×: Group IV

SDS, standard deviation score; M, month health examination

Figure 5 The BMI SDS of all boys and girls in Fukushima Prefecture

◆: Control Group, ■: Group I, ▲: Group II, ✕: Group IV

BMI, body mass index; SDS, standard deviation score; M, month health examination

※P value < 0.016 ※※P value < 0.01 ※※※P value < 0.001

Figure 6 ΔBMI SDS of all boys and girls in Fukushima Prefecture

◆: Control Group, ■: Group I, ▲: Group II, ✕: Group IV

BMI, body mass index; SDS, standard deviation score; ΔBMI SDS, BMI SDS between

two consecutive health examinations; M, month health examination

※P value < 0.016 ※※P value < 0.01 ※※※P value < 0.001

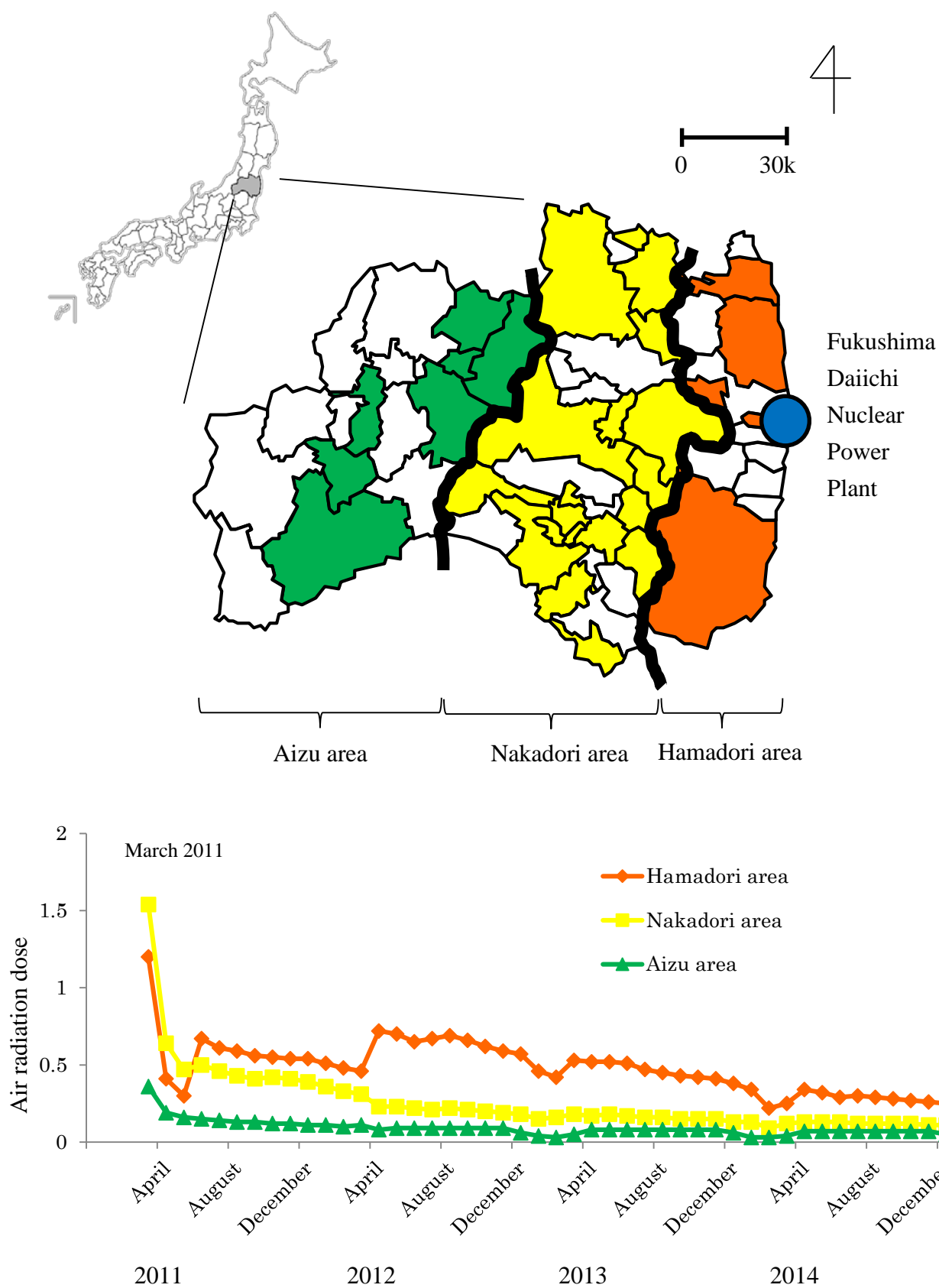


Figure 1

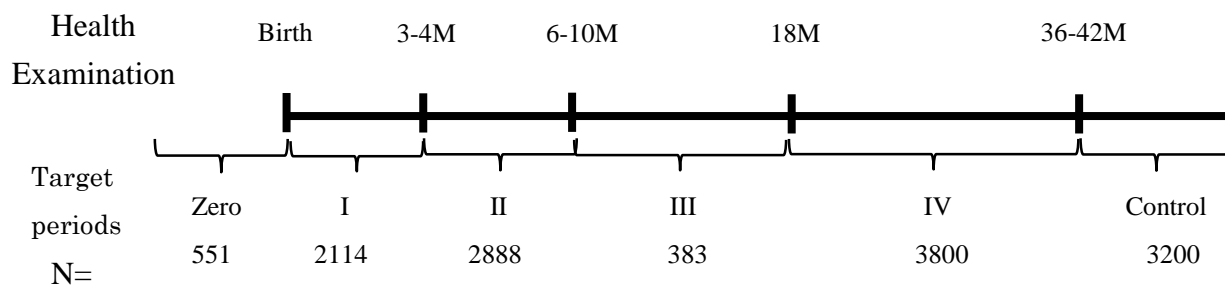


Figure 2

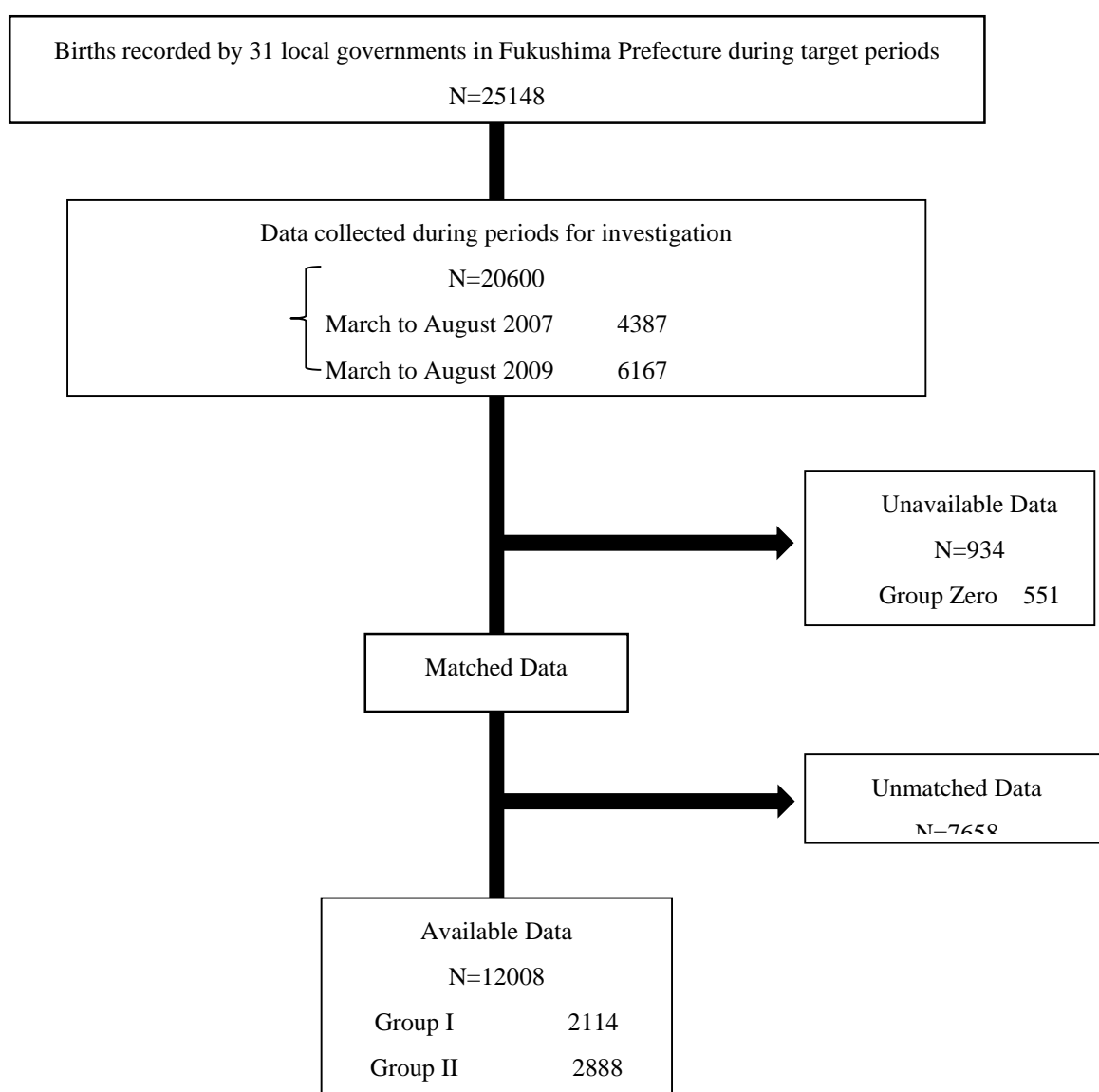


Figure 3

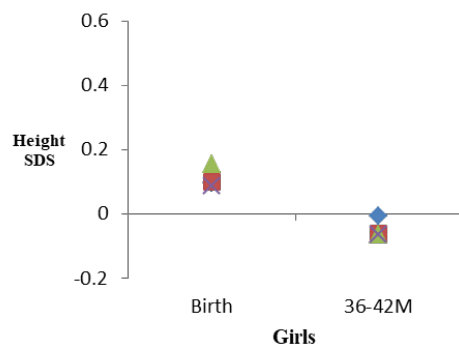
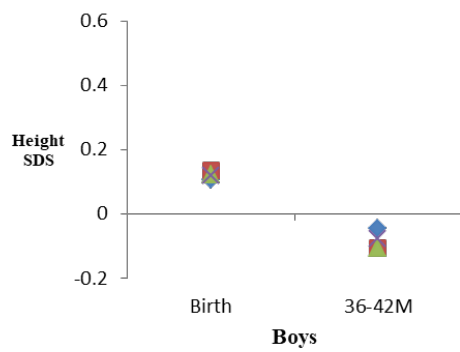


Figure 4

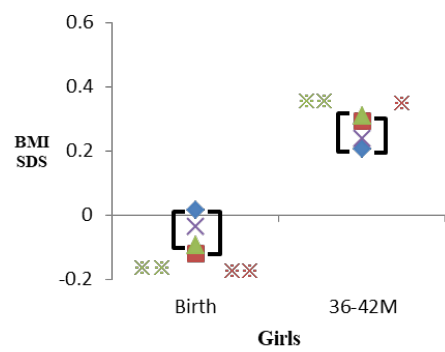
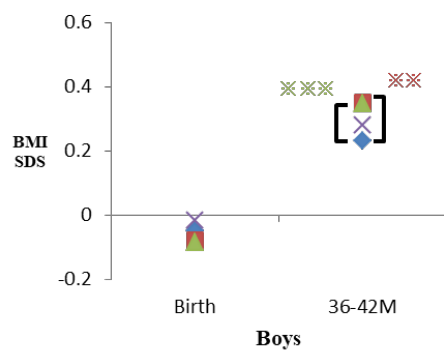


Figure 5

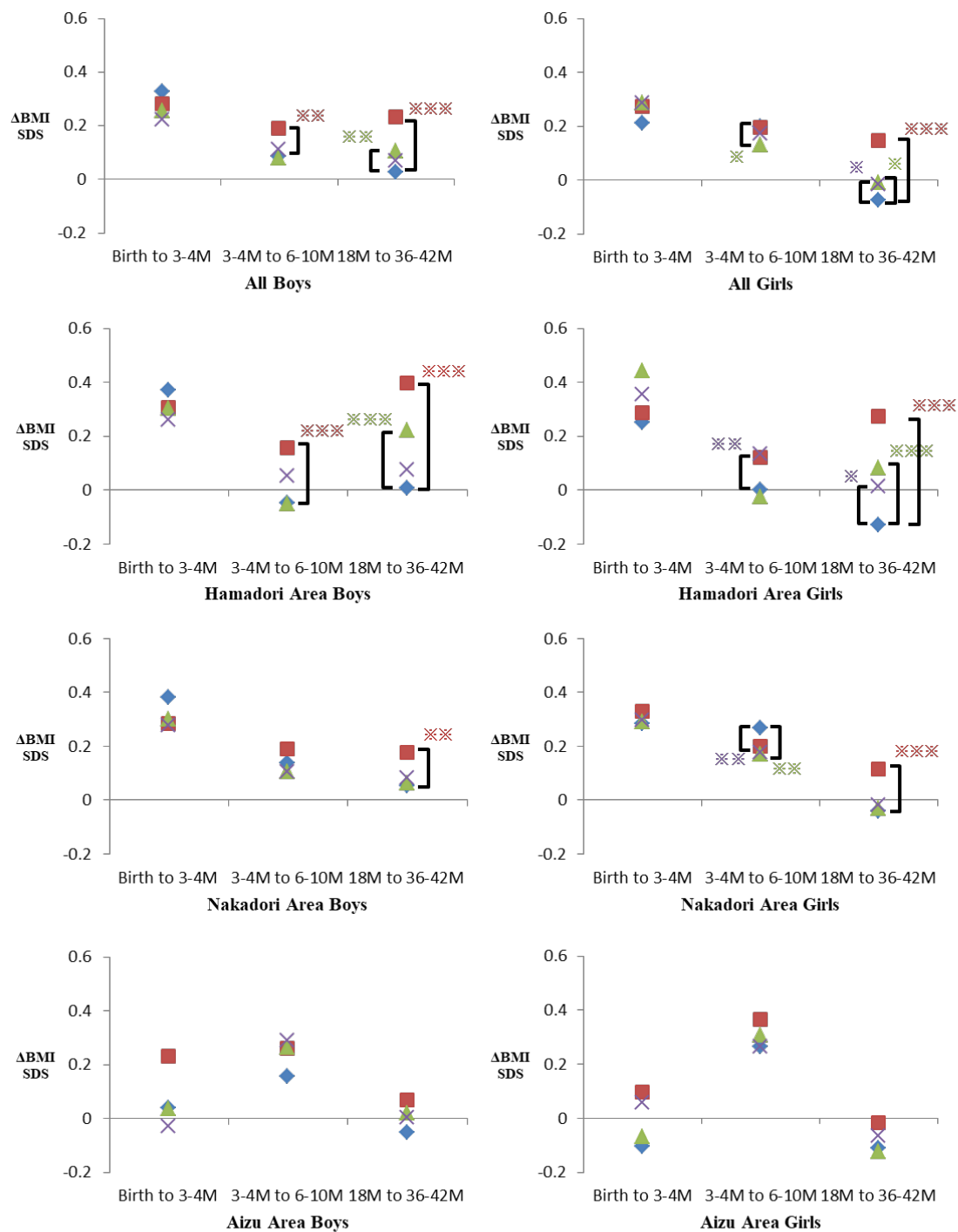


Figure 6

Table 1 The sex distribution in each area and group in those with complete data

	sex	Complete Data ^{※1}					
		Zero	I	II	III	IV	Control
All Area ^{※2}	Boys	297	(836)1,061	(1,174)1,478	180	(1,492)1,911	(1,414)1,645
	Girls	254	(843)1,053	(1,121)1,410	203	(1,436)1,889	(1,333)1,561
Hamadori Area	Boys	145	351	460	26	573	477
	Girls	115	328	420	32	558	392
Nakadori Area ^{※2}	Boys	118	(330)555	(505)809	129	(688)1,107	(732)963
	Girls	116	(371)581	(508)797	144	(680)1,133	(730)958
Aizu Area	Boys	34	155	209	25	231	205
	Girls	23	144	193	27	198	211

※1 the only data from group I, II, IV and Control are used in this study.

※2 the number in brackets represents the number of children who were examined at birth. They are fewer than the number of other health examination periods because some data on height at birth were missing in Nakadori area.

Table 2 Number, Average (95% Confidence Interval) and P-value for Height SDS in Fukushima Prefecture

Height SDS	All Boys					
	Birth			36–42M		
	n	Average (95%CI)	P value	n	Average (95%CI)	P value
Control group	1,414	0.105 (0.050 to 0.160)		1,645	-0.046 (-0.091 to -0.001)	
Group I	836	0.136 (0.065 to 0.207)	0.522	1,061	-0.106 (-0.164 to -0.048)	0.110
Group II	1,174	0.121 (0.064 to 0.178)	0.728	1,478	-0.107 (-0.154 to -0.060)	0.069
Group IV	1,492	0.119 (0.069 to 0.169)	0.748	1,911	-0.079 (-0.122 to -0.036)	0.300
Height SDS	All Girls					
	Birth			36–42M		
	n	Average	P value	n	Average	P value
Control group	1,333	0.097 (0.038 to 0.156)		1,561	-0.006 (-0.055 to 0.043)	
Group I	843	0.098 (0.025 to 0.171)	0.979	1,053	-0.063 (-0.122 to -0.004)	0.143
Group II	1,121	0.153 (0.096 to 0.210)	0.187	1,410	-0.065 (-0.115 to -0.015)	0.100
Group IV	1,436	0.088 (0.035 to 0.141)	0.816	1,889	-0.064 (-0.107 to -0.021)	0.080

M; month health examination

Table 3 Number, Average (95% Confidence Interval) and P-value for BMI SDS in Fukushima Prefecture

BMI SDS	All Boys					
	Birth			36–42M		
	n	Average (95%CI)	P value	n	Average (95%CI)	P value
Control group	1,414	-0.048 (-0.102 to 0.006)		1,645	0.232 (0.187 to 0.277)	
Group I	836	-0.080 (-0.146 to -0.014)	0.479	1,061	0.351 (0.298 to 0.404)	0.001
Group II	1,174	-0.085 (-0.143 to -0.027)	0.363	1,478	0.346 (0.302 to 0.390)	<0.001
Group IV	1,492	-0.017 (-0.068 to 0.034)	0.406	1,911	0.281 (0.239 to 0.323)	0.120
BMI SDS	All Girls					
	Birth			36–42M		
	n	Average (95%CI)	P value	n	Average (95%CI)	P value
Control group	1,333	0.016 (-0.041 to 0.073)		1,561	0.206 (0.162 to 0.250)	
Group I	843	-0.119 (-0.190 to -0.048)	0.004	1,053	0.293 (0.240 to 0.346)	0.013
Group II	1,121	-0.094 (-0.155 to -0.033)	0.009	1,410	0.310 (0.265 to 0.355)	0.001
Group IV	1,436	-0.035 (-0.088 to 0.018)	0.202	1,889	0.237 (0.196 to 0.278)	0.300

M; month health examination

Table 4 Number, Average (95% Confidence Interval) and P-value for Δ BMI SDS in Fukushima Prefecture

Δ BMI SDS	All Boys								
	Birth to 3–4M			3–4M to 6–10M			18M to 36–42M		
	n	Average (95%CI)	P value	n	Average (95%CI)	P value	n	Average (95%CI)	P value
Control group	1,414	0.329 (0.261 to 0.397)		1,645	0.086 (0.046 to 0.126)		1,645	0.028 (-0.006 to -0.062)	
Group I	836	0.284 (0.200 to 0.368)	0.415	1,061	0.189 (0.145 to 0.233)	0.001	1,061	0.234 (0.192 to 0.276)	<0.001
Group II	1,174	0.255 (0.183 to 0.327)	0.144	1,478	0.079 (0.380 to 0.120)	0.808	1,478	0.106 (0.071 to 0.141)	0.002
Group IV	1,492	0.224 (0.157 to 0.291)	0.031	1,911	0.112 (0.078 to 0.146)	0.330	1,911	0.070 (0.039 to 0.101)	0.071
Δ BMI SDS	All Girls								
	Birth to 3–4M			3–4M to 6–10M			18M to 36–42M		
	n	Average (95%CI)	P value	n	Average (95%CI)	P value	n	Average (95%CI)	P value
Control group	1,333	0.212 (0.143 to 0.281)		1,561	0.200 (0.162 to 0.238)		1,561	-0.072 (-0.109 to -0.035)	
Group I	843	0.273 (0.184 to 0.362)	0.285	1,053	0.198 (0.150 to 0.246)	0.929	1,053	0.146 (0.108 to 0.184)	<0.001
Group II	1,121	0.285 (0.211 to 0.359)	0.157	1,410	0.130 (0.089 to 0.171)	0.013	1,410	-0.009 (-0.042 to 0.024)	0.013
Group IV	1,436	0.287 (0.222 to 0.352)	0.123	1,889	0.174 (0.139 to 0.209)	0.310	1,889	-0.013 (-0.043 to 0.017)	0.013

Δ BMI SDS	Hamadori Boys								
	Birth to 3–4M			3–4M to 6–10M			18M to 36–42M		
	n	Average (95%CI)	P value	n	Average (95%CI)	P value	n	Average (95%CI)	P value
Control group	477	0.371 (0.249 to 0.493)		477	-0.047 (-0.124 to 0.030)		477	0.008 (-0.052 to -0.068)	
Group I	351	0.305 (0.178 to 0.432)	0.472	351	0.159 (0.085 to 0.233)	<0.001	351	0.396 (0.319 to 0.473)	<0.001
Group II	460	0.305 (0.191 to 0.419)	0.440	460	-0.049 (-0.119 to 0.021)	0.972	460	0.224 (0.163 to 0.285)	<0.001
Group IV	573	0.262 (0.157 to 0.367)	0.180	573	0.053 (-0.007 to 0.113)	0.042	573	0.075 (0.015 to 0.135)	0.127
Δ BMI SDS	Hamadori Girls								
	Birth to 3–4M			3–4M to 6–10M			18M to 36–42M		
	n	Average (95%CI)	P value	n	Average (95%CI)	P value	n	Average (95%CI)	P value
Control group	392	0.250 (0.115 to 0.385)		392	0.001 (-0.078 to 0.080)		392	-0.127 (-0.206 to -0.048)	
Group I	328	0.287 (0.144 to 0.430)	0.713	328	0.121 (0.041 to 0.201)	0.039	328	0.275 (0.208 to 0.342)	<0.001
Group II	420	0.442 (0.325 to 0.559)	0.034	420	-0.026 (-0.098 to 0.046)	0.625	420	0.083 (0.019 to 0.148)	<0.001
Group IV	558	0.355 (0.248 to 0.462)	0.229	558	0.135 (0.074 to 0.196)	※1 0.008	558	0.015 (-0.043 to 0.073)	0.004
Δ BMI SDS	Nakadori Boys								
	Birth to 3–4M			3–4M to 6–10M			18M to 36–42M		

	n	Average (95%CI)	P value	n	Average (95%CI)	P value	n	Average (95%CI)	P value
Control group	732	0.383 (0.290 to 0.476)		963	0.137 (0.085 to 0.189)		963	0.054 (0.008 to 0.100)	
Group I	330	0.285 (0.146 to 0.424)	0.252	555	0.189 (0.125 to 0.253)	0.234	555	0.178 (0.123 to 0.233)	0.001
Group II	505	0.299 (0.185 to 0.413)	0.262	809	0.104 (0.048 to 0.160)	0.394	809	0.062 (0.014 to 0.110)	0.082
Group IV	688	0.276 (0.175 to 0.377)	0.127	1,107	0.106 (0.061 to 0.151)	0.374	1,107	0.081 (0.041 to 0.121)	0.384
Δ BMI SDS		Nakadori Girls							
	Birth to 3–4M			3–4M to 6–10M			18M to 36–42M		
	n	Average (95%CI)	P value	n	Average (95%CI)	P value	n	Average (95%CI)	P value
Control group	730	0.284 (0.193 to 0.375)		958	0.267 (0.220 to 0.314)		958	-0.041 (-0.086 to 0.004)	
Group I	371	0.392 (0.199 to 0.459)	0.570	581	0.200 (0.134 to 0.266)	0.090	581	0.114 (0.062 to 0.166)	<0.001
Group II	508	0.291 (0.178 to 0.404)	0.926	797	0.169 (0.115 to 0.223)	0.006	797	-0.030 (-0.074 to 0.014)	0.726
Group IV	680	0.297 (0.203 to 0.391)	0.840	1,133	0.117 (0.132 to 0.222)	[※] 0.007	1,133	-0.018 (-0.056 to 0.020)	0.435
Δ BMI SDS		Aizu Boys							
	Birth to 3–4M			3–4M to 6–10M			18M to 36–42M		
	n	Average (95%CI)	P value	n	Average (95%CI)	P value	n	Average (95%CI)	P value

Control group	205	0.041 (-0.137 to 0.219)		205	0.157 (0.049 to 0.265)		205	-0.050 (0.006 to -0.006)	
Group I	155	0.230 (0.043 to 0.417)	0.154	155	0.261 (0.152 to 0.370)	0.193	155	0.070 (-0.034 to 0.174)	0.092
Group II	209	0.038 (-0.117 to 0.193)	0.979	209	0.266 (0.157 to 0.375)	0.167	209	0.021 (-0.063 to 0.105)	0.258
Group IV	231	-0.028 (-0.199 to 0.143)	0.583	231	0.291 (0.193 to 0.389)	0.072	231	0.005 (-0.076 to 0.086)	0.370

ΔBMI SDS	Aizu Girls								
	Birth to 3–4M			3–4M to 6–10M			18M to 36–42M		
	n	Average (95%CI)	P value	n	Average (95%CI)	P value	n	Average (95%CI)	P value
Control group	211	-0.105 (-0.267 to 0.057)		211	0.266 (0.162 to 0.370)		211	-0.112 (-0.213 to -0.011)	
Group I	144	0.095 (-0.123 to 0.313)	0.138	144	0.365 (0.237 to 0.493)	0.236	144	-0.017 (-0.112 to 0.078)	0.200
Group II	193	-0.069 (-0.240 to 0.102)	0.766	193	0.309 (0.200 to 0.418)	0.581	193	-0.124 (-0.202 to -0.046)	0.851
Group IV	198	0.058 (-0.097 to 0.213)	0.152	198	0.266 (0.153 to 0.379)	0.992	198	-0.067 (-0.154 to 0.020)	0.506

M; month health examination

※1 Data before the 2011 earthquake disaster